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# HOW TO DETECT OUTBREAKS OF INSECTS AND SAVE THE GRAIN CROPS

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A billbug, much enlarged

FARMERS' BULLETIN 835

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology

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MAXIMUM YIELDS of grain must be produced not only during the present year but for several years to come. The present international situation renders this imperative. Insects are responsible for great reductions in grain crops annually, but such losses are largely preventable. The injuries caused by insects often remain unnoticed except where their work is very conspicuous.

Therefore, WATCH THE CROPS CAREFULLY FOR EVIDENCES OF INSECT INJURY AND APPLY REMEDIES PROMPTLY. This bulletin will tell you how to fight the Hessian fly, chinch bug, army worm, cutworms, grasshoppers, white grubs, billbugs, corn root-aphis, and wireworms.

Keep in close touch with your county agricultural agent, State experiment station, or Federal entomological station. Report all serious insect outbreaks to these officials and seek their expert advice in all cases of doubt regarding treatment for, or identity of, insect pests. Have a supply of insecticides and a practical spraying outfit on hand at all times. WATCH YOUR CROPS.

# HOW TO DETECT OUTBREAKS OF INSECTS AND SAVE THE GRAIN CROPS.

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A GREAT portion of the annual loss to the grain crop due to insect injuries can be avoided by vigilance and vigorous action on the part of the grain growers. Insect outbreaks frequently originate within limited areas, and when this is the case it often is possible to stamp them out before any great damage has occurred. In other instances the outbreaks are of general origin, and then community action is essential in order that the inroads of the pest may be overcome. The most serious insect enemies of cereal crops, such as the Hessian fly, the chinch bug, and white grubs, belong to the latter class. In the case of these and other widely distributed foes of the grains no means of stopping their ravages will be fully successful until community action can be secured in adopting the methods of combat at present advocated by entomologists.

Fall plowing, doubtless, is the most universally beneficial practice for the control of the insect pests of cereal crops, and this measure should be adopted except where it is rendered impossible by local agricultural conditions. Corn never should be planted on freshly broken sod land, because this practice is almost certain to expose the crop to the ravages of cutworms, wireworms, and white grubs. Crops belonging to the bean family, such as cowpeas, soy beans, clover, alfalfa, etc., may be interposed safely between sod and grain and especially between sod and corn, in order that injury to the grain crops by these pests may be avoided.

## HESSIAN FLY.[1]

The Hessian fly, found throughout almost the entire winter-wheat region (fig. 1), is a minute, mosquitolike fly which lays its eggs upon

[1] *Phytophaga destructor* Say.

the leaves of wheat. These eggs hatch into little maggots which crawl down into the leaf sheaths. There they live upon the plant's sap, which they obtain by gnawing into the soft portions of the stem. Usually two, but sometimes three or more, generations of the insect occur during a year.

One main generation of flies (see fig. 2) appears in the fall, the large proportion of the maggots becoming full-grown before the severe weather of winter arrives, when they change into brown seed-like forms known as "flaxseeds." These may be found within the leaf sheaths in young wheat plants, usually at or beneath the surface of the soil. These overwintering "flaxseeds" produce the spring generation of flies. These, in turn, lay eggs from which hatch maggots that cause great injury to wheat, noticed about harvest time, when the straws break off and the crop is said to be "straw fallen."

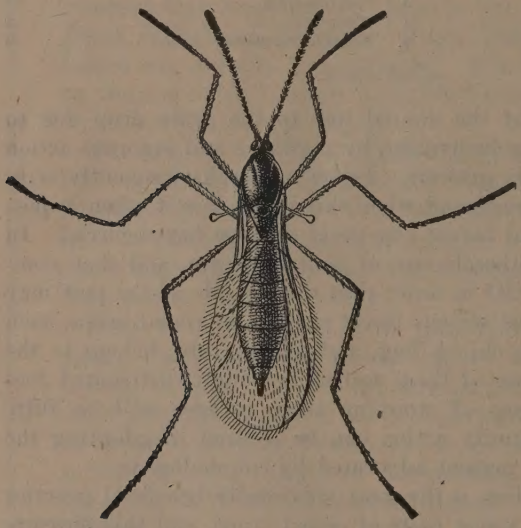

FIG. 1.—The Hessian fly (*Phytophaga destructor*): Adult female. Much enlarged.

*After the Hessian fly has once thoroughly infested the crop of wheat there is no known means of saving it, and the only known means of preventing damage from the fly is to keep it out of the wheat.*

For this reason the young wheat should be examined thoroughly in order that the presence of the brown "flaxseeds" may be detected late in winter or very early in the spring, and if these are found to be present in large numbers it will pay to plow down the wheat at once and prepare to plant corn, oats, or some other crop in its place. In this way the fertilizing value of the green crop will be retained in the soil and it will still be possible to secure a crop of grain or vegetables from the field during the current year.

The remedies for the Hessian fly are entirely preventive and are as follows:

(1) Immediately after harvest, or as soon thereafter as practicable, plow the wheat stubble down deeply, at least 5 inches deep if possible, in order to destroy the maggots and "flaxseeds" which may remain in it. This is for the protection of future crops.

(2) Pay great attention to the preparation of the seed bed for the wheat by plowing early and working and packing the soil thoroughly in order to eliminate lumps and clods, thus producing a finely pulverized, compact, and moisture-conserving bed for the seed.

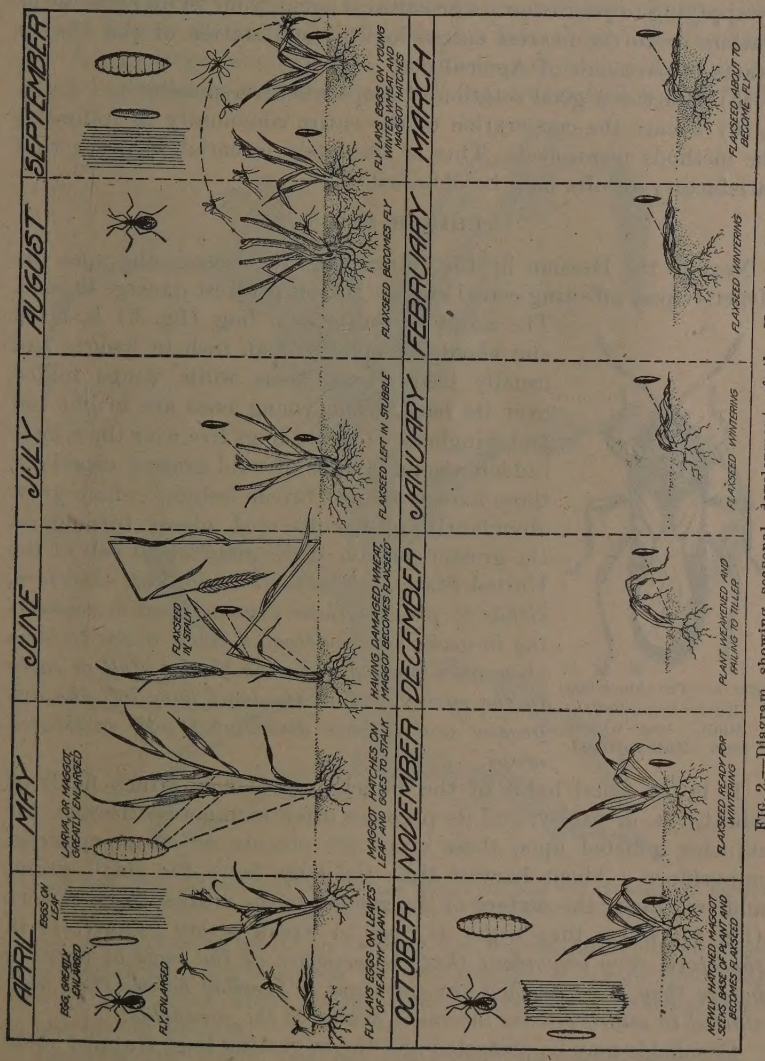


FIG. 2.—Diagram showing seasonal development of the Hessian fly.

(3) *Destroy all volunteer wheat* by plowing or disking, as such wheat serves to carry the flies over from fall to spring, even though most of the fields of wheat have been treated properly and contain no flies. *One field in which volunteer wheat is allowed to remain may*

*breed enough Hessian flies to infest a whole neighborhood where the grain is otherwise free from the fly.*

(4) Take care that the sowing of wheat in the fall is delayed until the fly-free date. Information regarding this date can be obtained by applying to your county agricultural agent, your State experiment station, or to the nearest entomological field station of the United States Department of Agriculture.

(5) Practice a good rotation of crops wherever possible.

(6) Secure the cooperation of the entire community in following the methods mentioned. This is absolutely essential in order that satisfactory results may be obtained.[1]

## CHINCH BUG.[2]

Next to the Hessian fly the chinch bug doubtless is the most destructive pest affecting cereal crops. It does greatest damage to corn.

FIG. 3.—The chinch bug (*Blissus leucopterus*): Adult, long-winged form. Much enlarged.

The adult or full-grown bug (fig. 3) is black and about one-eighth of an inch in length, and usually bears conspicuous white wings folded over its back. The young ones are bright red and wingless. The old bugs live over the winter hidden among clumps of wild grasses, especially those known as the "broom sedges," which grow abundantly in uncultivated places throughout the greater portion of the main wheat belt of the United States. *It is most important, therefore, either to prevent these grasses from accumulating in waste or uncultivated fields or else to burn them over while dry during the late fall or early in the spring, before the bugs have left the dry grasses and become distributed over cultivated crops.*

It is the usual habit of the chinch bug first to attack fields of wheat, rye, or barley, and its presence often is unnoticed because the injuries inflicted upon these crops are obscure or of no apparent importance. About harvest time the bugs leave the small grains and crawl over the surface of the ground to the nearest fields of corn (fig. 4), where they begin at once to wreak severe injury. *It is, therefore, very important that the presence of the bugs be detected before they have reached the corn and if possible before they have started to migrate from the small grains to the cornfields.*

Cornfields may be protected and the migrating bugs trapped about the time of wheat harvest, as follows: Plow a deep furrow along

[1] Further information regarding this pest is contained in Farmers' Bulletin 640, which may be secured free of charge upon application to the Secretary of Agriculture, Washington, D. C.

[2] *Blissus leucopterus* Say.

the edge of the field, running the land side of the plow toward the field to be protected. In dry weather the sides of the furrow can be made so smooth and the sides so steep that the bugs will find it easier to crawl along the bottom than to climb up the sides. Circular holes from 30 to 40 feet apart, made with a post-hole digger, then may be dug in the bottom of the trench. Into these holes the bugs will fall in large numbers, and here they may be killed easily by sprinkling kerosene oil over them. A log dragged back and forth

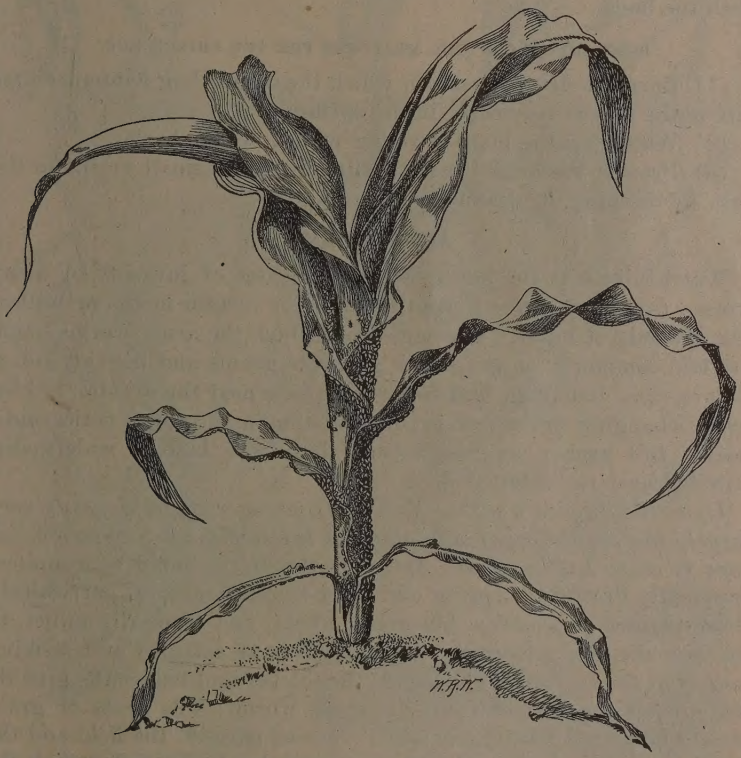

FIG. 4.—Corn plant infested with chinch bugs. When the bugs are as numerous as this on the corn it can not be saved. *Do not let them reach the corn.*

along the furrow is useful in keeping the bottom and sides in good condition during dry weather. In wet weather a line of liquid tar or crude petroleum, which the bugs will not cross, may be maintained in the furrow bottom.

Spraying for chinch bugs has not proved successful except on a small scale and when conducted by an expert, the difficulty being that the substances which kill the bug are almost sure to kill the corn also. *The thing to do is to discover the bugs before they reach the corn and keep them out of it by the methods described above.*

In case the bugs have reached only the first few rows of corn, however, they may be killed by spraying with a solution of one of the commonly used commercial washing powders prepared as follows: Dissolve 1 pound of washing powder in 2 gallons of boiling water. This is to be used as a stock solution; when ready to spray, dilute by adding 2 gallons of cold water to 1 of the stock solution, and apply to the infested rows with an ordinary force pump and sprayer. In order to be effective the soap-powder solution must come into contact with the bugs.

#### SUMMARY OF CONTROL MEASURES FOR THE CHINCH BUG.

(1) Burn the dried grasses in which the chinch bug winters, either late in the fall or very early in the spring.

(2) Watch for the bugs in young wheat, rye, or barley.

(3) Prevent the bugs from traveling from the small grains to the corn by ditching, as described.[1]

### ARMY WORM.[2]

Watchfulness is the key to success in cases of invasion by army worms (see fig. 5), which are the young of certain moths or millers that fly only at night. The eggs from which the army worms hatch are laid commonly on grasses or grasslike grains and the tiny caterpillars, upon hatching, feed for several days near the ground, hidden by overhanging grasses or grains and thus may escape notice until nearly full grown, by which time they have become widely distributed over the infested fields.

*Upon the discovery of the pest in its younger stages depends very largely the possibility of stamping out infestations before serious injury to crops has occurred.* Meadows therefore should be examined frequently during the spring and early summer months, particularly those planted to timothy, bluegrass, wheat, and especially millet, to discover the young worms. One should not be satisfied with looking merely at the surface of the stand; the thicker and longer the growth, the greater the danger from the army worm. The grass or grain should be parted with the hands in various parts of the field and the lower portions of the growth examined closely, in order that the presence of the small, greenish caterpillars may be discovered, and if these be found in any number the area covered by the infestation should be determined and vigorous action taken at once to destroy the worms before they become large enough to begin their journey to other parts of the farm. If the infested spot be small, the grass or grain can be mowed off and straw scattered over the spot and burned, thus destroying the worms. If the caterpillars have become dis-

[1] Additional information regarding the chinch bug is contained in Farmers' Bulletin 657, which may be secured free of charge by application to the Secretary of Agriculture, Washington, D. C.

[2] *Cirphia unipuncta* Haw.

FIG. 5.—Stages and work of the true army worm (*Cirphis unipuncta*) and some of its insect enemies: *a*, Parent or moth; *b*, full-grown larva; *c*, eggs; *d*, pupa in soil; *e*, parasitic fly, *Winthemia quadripustulata*, laying its eggs on an army worm; *f*, a ground beetle, *Calosoma calidum*, preying upon an army worm, and, at right, Calosoma larva emerging from burrow; *g*, a digger wasp, *Sphex* sp., carrying an army worm to its burrow; *h*, *Enicospilus purgatus*, a wasplike parasite of the army worm. All about natural size.

tributed over a considerable area, this can be marked off by stakes and the crop sprayed heavily with a solution of Paris green at the rate of 1 pound to 50 gallons of water, or of arsenate of lead at the rate of 2 pounds of the paste or 1 pound of the powder to 50 gallons of water. In case this poison is used, care should be exercised in preventing stock from gaining access to the poisoned grass or grain and being injured or killed by eating it. It is best by far to sacrifice a portion of the crop, if the destruction of the pest can be accomplished thereby, because if the army worms are not destroyed they will take the crop in any case and probably devastate other portions of the farm.

#### POISONED BAITS FOR THE ARMY WORM.

Poisoned baits have long been used as a means of destroying the numerous species of cutworms and also the army worm. An efficient bait of this kind may be prepared and used as follows: To 50 pounds of wheat bran and 1 pound of Paris green or 2 pounds of powdered arsenate of lead add the juice of one-half dozen oranges or lemons. Then bring the mass to a stiff dough by adding low-grade molasses or sirup, preferably molasses, and scatter the mixture broadcast in small pieces throughout the infested field. This poisoned bait may be used safely in alfalfa and cornfields where it is desired, if possible, to save the crop for forage.

#### MECHANICAL MEASURES AGAINST THE ARMY WORM.

In case the worms are not discovered until they have begun to travel in a mass, usually they can be destroyed by furrowing or ditching completely around the infested area (see fig. 6). The worms will fall into the ditches and can be killed easily by crushing them with a log dragged back and forth through the ditch or furrow. If shallow postholes are sunk in the bottom of the ditch at intervals of about 20 feet, the worms will crawl along the ditch bottoms and fall into the holes, where they may be destroyed by crushing or other means. If the subsoil be of such a nature that water penetrates it but slowly, the postholes may be filled partially with water, on the top of which a layer of coal oil or petroleum may be poured. The worms die almost immediately upon falling into such holes.

#### SUMMARY OF CONTROL MEASURES FOR THE ARMY WORM.

(1) Watch fields of growing grass and grain carefully, especially the meadows, during the spring and early summer months, to discover the army worms before they become full grown and spread over the entire farm. *When the worms are discovered at work, do not lose a minute, but attack them vigorously by means of the measures outlined in the foregoing pages.*

(2) Poison them by spraying crops not intended for forage with 1 pound of Paris green to 50 gallons of water, or with 2 pounds of powdered arsenate of lead to 50 gallons of water. In case the Paris green is used on tender plants, like corn, add 2 pounds of freshly slaked lime to 50 gallons of the mixture. This is to prevent burning the tender plants. Where spraying is not practicable, the use of the poisoned-bran bait already mentioned is strongly recommended.[1]

(3) In case the worms are crawling in a body, surround them with a furrow or ditch and crush them with a log drag as they fall into it.

FIG. 6.—Ditch prepared to entrap marching army worms. A log, dragged back and forth through the ditch, crushes the worms that have fallen into it.

## CUTWORMS.

Numerous complaints of the ravages of cutworms (see fig. 7), especially in corn, are received by the department each season. Prompt action is necessary for controlling cutworms after their presence becomes noticeable in the spring, which usually is about the time the corn begins to sprout. *Since the crop may be destroyed by cutworms between the time an inquiry is sent to the department upon the appearance of the worms and the time a reply can be received, the importance of recognizing these insects and knowing how to control them is evident.*

[1] Further information regarding this pest is contained in Farmers' Bulletin 731, which may be secured free of charge upon application to the Secretary of Agriculture, Washington, D. C.

Cutworm injury, which usually consists in the cutting off of the plants at or a little below the surface of the ground, almost invariably occurs in the spring, beginning as soon as the first plants sprout and continuing until late June or early July, by which time the worms are full grown. The worms feed at night and rest during the day beneath débris or in the soil from one-half to 1 inch below the surface, and since in most cases they resemble the soil closely in color the cause of the injury often is not apparent. However, if the soil surrounding the cut-off plant be examined carefully, the culprit probably will be found curled up beneath the surface as shown at *c* in figure 7.

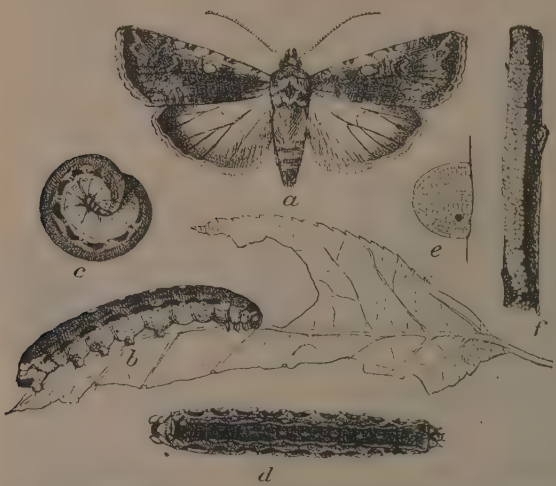


FIG. 7.—Variegated cutworm (*Peridroma margaritosa*): *a*, Moth; *b*, normal form of caterpillar, side view; *c*, same in curved position; *d*, dark form, view of back; *e*, greatly enlarged egg, seen from side; *f*, egg mass on twig.

### SEASONAL HISTORY OF CUTWORMS.

The various species of cutworms are known under a number of names, such as glassy cutworm, greasy cutworm, variegated cutworm, clay-backed cutworm, etc., but the injuries caused by them are very similar and their habits in general are also much the same.

The parents of cutworms are grayish or brownish moths, or "millers," which commonly occur at lights during summer evenings. Each moth may lay from 200 to 500 eggs (see fig. 7, *e*, *f*), either in masses or singly, in fields covered with dense vegetation, and hence the eggs are to be found more often than elsewhere in cultivated fields which have been in grass or weeds the preceding fall. The eggs hatch in the fall, a few weeks after they are laid, usually during September, and the young cutworms, after feeding on grass and other vegetation until cold weather, pass the winter as partly grown caterpillars. If an infested field is left to grass, no noticeable injury is likely to occur; but when it is broken up and planted to corn or other wide-row crops, the worms, suddenly being placed on "short rations," play havoc with the newly planted crops, the nearly full-grown worms feeding greedily and consuming an enormous amount of food. In northern latitudes they attain full growth and stop feeding in late

June or early July, and then change to the pupal or resting stage. The injury often ceases so suddenly that farmers are at a loss to account for the fact.

### CONTROL OF CUTWORMS.

If land that has been in grass for a considerable time and is likely to contain cutworms is to be planted to corn the following spring, it should be plowed in midsummer or early fall, about the time the eggs are laid or, better, before the eggs are laid, for then vegetation which is suitable for the moths to lay their eggs upon is removed. The earlier the preceding year grasslands to be planted to corn are plowed, the less will be the probability that the cutworm moths will have laid their eggs thereon, and the less, consequently, will be the danger of injury by cutworms the following year.

Late fall and winter plowing of grasslands, although not as effective as early plowing, will destroy many of the hibernating cutworms, as well as such other important corn pests as white grubs, and should be practiced when earlier plowing is impracticable.

Pasturing hogs upon land supposed to harbor cutworms is a beneficial practice, as these animals root up and devour insects of many kinds, including cutworms, in large numbers. Farm poultry, allowed to follow the plow, is of great value.

When cutworms are found to be abundant on corn land, the use of the poisoned bait described on page 10 is recommended. In fields known to be infested, the distribution of this bait should be begun as soon as the corn appears above the ground, so that the cutworms may be eliminated as quickly as possible and the injured hills replanted promptly. During the warmer spring months cutworms do most of their feeding at night and burrow into the soil to the depth of an inch or two during the day, so that the bait usually will be more effective if applied during the late afternoon and early evening hours.

Frequently cutworms migrate to cultivated fields from adjoining grassland, and in such cases the crops can be protected by running a narrow band of the poisoned bait around the edge of the field or along the side nearest the source of infestation.[1]

### GRASSHOPPERS.[2]

Grasshoppers are injuriously abundant in various parts of the United States every year. Their ravages, which occur chiefly on alfalfa and the grasses, can be prevented largely by cheap and practical means, especially where vigilance is exercised. These pests may be discovered in their young stages, when it is easy to control them

[1] Further information regarding these pests is contained in Farmers' Bulletin 739, which may be secured free of charge upon application to the Secretary of Agriculture, Washington, D. C.

[2] *Melanoplus* spp., etc.

by means of the poisoned baits described below. The more injurious kinds of grasshoppers nearly all live over the winter in the eggs which are placed in the ground by the old grasshoppers in late summer or early fall. The eggs hatch the following spring, usually during the months of May and June in the Northern States. *Every effort should be made to discover the young insects* (fig. 8) *before*

FIG. 8.—Young grasshoppers feeding on clover. In this stage they are easily killed by poisoning.

*they have attained any considerable size*, when the injury done by them is still very slight, and when they are wingless and easily killed by poisons or mechanical means.

#### POISONED BAITS FOR GRASSHOPPERS.

The most effective remedies yet discovered for grasshoppers are the following poisoned baits:

The mixture known as the poisoned-bran bait has proved to be a simple, reliable, and cheap method of destroying grasshoppers, and has been applied with signal success throughout many portions of the United States. It is made up as follows: Wheat bran, 25 pounds; Paris green, 1 pound, or powdered arsenate of lead, 2 pounds; lemons or oranges, 6 finely chopped fruits; low-grade molasses, such as refuse from sugar factories, or cattle molasses, known as "black strap," 2 quarts; water, 2 to 3 gallons. The bran and Paris green or arsenate of lead are thoroughly mixed while dry, the fruits are then finely chopped and added, and lastly the molasses and water are poured over the bait and the whole thoroughly kneaded. A coarse-flaked bran is most desirable, although where this can not be obtained easily ordinary middlings or alfalfa meal may be substituted; a low-grade, strong-smelling sirup or molasses, however, is essential to the entire success of the undertaking. Crushed ripe tomatoes, watermelons, or limes may be substituted for the lemons or oranges, if necessary. In California and other semiarid regions water should be added to the bait at the rate of 4 gallons to 25 pounds of bran, as in these climates the bait dries out very rapidly and the extra moisture is necessary in order to attract the grasshoppers.

Another effective bait of similar character is the modified Criddle mixture. This is prepared as follows: Fresh horse droppings, one-half barrel; Paris green, 1 pound, or powdered arsenate of lead, 2 pounds; finely chopped oranges or lemons, 6 to 8 fruits; water sufficient to make a moist but not sloppy mash. This bait must be mixed thoroughly before being distributed, and as most people object to handling this mixture with the bare hands, a pair of cheap rubber gloves may be used for the purpose. Both the poisoned-bran bait and the modified Criddle mixture are distributed over the infested fields by sowing broadcast, either on foot or from a light wagon or buggy.

In applying the poisoned bait in orchards, care must be taken to avoid distributing it close to the trees, because severe injury to fruit trees occasionally results from heavy applications of arsenicals.

*Proper time of day for applying the poisoned baits.*—The time of day chosen for distributing the poisoned baits has an important bearing upon the results secured. In California and other semiarid regions the bait should be distributed in late afternoon or early evening, just before the grasshoppers ascend the plants on which they

usually pass the night. Apparently they are hungry and thirsty at this time and greedily take the bait if it be available. In the moister portions of the country, such as New England and Florida, the bait is best applied in the early morning. *Farmers should not be discouraged if the grasshoppers do not drop dead immediately upon eating the poison, as it usually takes 24 hours or more for the full effect of the baits to become apparent.*[1]

## WHITE GRUBS.[2]

White grubs (fig. 9) are the young of the common brown May beetles, or "June beetles," which begin to appear during the latter

FIG. 9.—A full-grown white grub. Greatly enlarged.

part of April and continue to be seen in the evening throughout the month of May and even as late as June. These beetles lay their eggs in the ground, preferably in timothy grasslands. The little grubs, upon hatching, feed largely upon decayed vegetable matter in the soil and therefore are not usually detected at this time. On the approach of cold weather they burrow deeply into the soil, where they sleep or hibernate during the winter. When the next spring arrives

[1] Further information regarding these pests is contained in Farmers' Bulletin 747, which may be secured free of charge upon application to the Secretary of Agriculture, Washington, D. C.

[2] *Lachnosterna* spp.

they approach the surface of the ground and begin to feed on the roots of grasses, corn, potatoes, strawberries, and seedling trees, especially conifers. They feed ravenously during this second year of their life and by fall are nearly full grown.

If land is found to be heavily infested with the grubs, it should be plowed thoroughly during the summer or early fall, the farm fowls being allowed to follow the plow in order that they may find and eat the grubs as these are brought to the surface. Chickens and other farm poultry are very fond of the insects. Hogs may be turned into such fields with profit, as it is their habit to root out and devour the grubs in great numbers.

On the approach of winter the nearly full-grown grubs once more descend deeply into the ground in order to hibernate until spring, when they come to the surface and feed for a few weeks. During the early summer months, usually in June, they go down deeply for the last time, changing to the resting stage or pupa during August, and then to the beetle in late September. The beetles remain in the ground all winter, coming up the following spring to feed upon the leaves of trees and lay their eggs in the soil for another generation. Thus it takes three years for most of the white grubs to complete their life cycle. Usually, therefore, they are especially abundant in any one region only one year in every three.

#### WHAT TO DO AT EACH STAGE OF WHITE-GRUB ATTACK.

*When heavy flights of May beetles are noticed.*—Use lantern traps during the beetles' flights. Spray trees with an arsenical, such as Paris green or arsenate of lead, to poison beetles feeding thereon. Plow grass and small grain land previous to October 1 to destroy young grubs recently hatched from eggs laid by May beetles.

*When small grubs are abundant in the fall.*—Plow thoroughly previous to October 1. Pasture hogs and allow chickens the run of fields when plowed. Seed such land to small grain or clover for the following year. Do not plant corn or potatoes on such land the following season.

*When small grubs are abundant in the spring.*—Seed such land to small grain or clover. Do not plant corn or wide-row crop in such land. Put corn, potatoes, field beans, etc., on ground which has been cleanly cultivated the preceding year. Pasture hogs on infested ground, and give chickens the run of fields when plowing and cultivating.

*When large grubs are abundant in the fall or spring.*—Plow infested land about October 1. Delay planting until the 15th or 20th of May, or a little later if practicable. Ground containing large grubs in spring should be plowed as soon after July 15 as practic-

able, as indicated below. Pasture hogs in infested fields wherever practicable.

*When beetles or pupæ are in the ground in summer.*—Plow thoroughly, so as to break clods, any time after July 15, but the sooner after that date the better. Pasture hogs in infested fields.[1]

## BILLBUGS.[2]

The billbugs, snout-beetles, or "elephant bugs" (see fig. 10 and illustration on title page), as they are variously termed, are hard-shelled beetles which live normally in sedges, rushes, or the large wild grasses found growing in moist, low ground. Corn planted in river and creek bottoms or other low places, especially in the southern portions of the country, is liable to injury by billbugs. The grubs, or young, of these beetles live inside the stems or roots of plants, and their injuries to corn usually are caused by their eating out the central portion of the stalk, thereby stunting and seriously injuring the corn plants. (See fig. 11.) The adult beetles also injure the corn, for they puncture the growing point or "bud" of the plant.

FIG. 10.—The maize billbug (*Sphenophorus maidis*): Adult, four times natural size.

### REMEDIES FOR BILLBUGS.

Some kinds of billbugs are eliminated easily by rotation of crops. Corn should not be followed by corn in the Atlantic Coastal Plain region of the South, but may be alternated with cotton, on which the billbugs can not live. *Land infested with these insects should always be plowed in the late summer or early fall*, for thus the winter quarters of the bugs are broken up. The immediate destruction of all sedges, rushes, chufa, or large swamp-inhabiting grasses in land intended to be planted to corn is especially necessary, as these plants are the natural food of the billbugs, and the insects can not be eliminated unless this is done.

## CORN ROOT-APHIS.[3]

The corn root-aphis (fig. 12) attacks the roots of corn throughout the States east of the Rocky Mountains, especially in those States

[1] Further information regarding these pests is contained in Farmers' Bulletin 543, which may be obtained free of charge upon application to the Secretary of Agriculture, Washington, D. C.

[2] *Sphenophorus* spp. The species illustrated on the title-page is *Sphenophorus æqualis* Gyll.

[3] *Aphis maidi-radicis* Forbes.

FIG. 11.—Corn plants showing effects of feeding of maize billbug in the field. Plant at left not attacked, the two at right attacked by larvæ.

within the main corn belt of the country, but also in the South Atlantic States. Since it passes almost its entire life underground, its presence frequently is not suspected. It is a small, stout, soft-

FIG. 12.—The corn root-aphis (*Aphis maidi-radicis*) : Winged, viviparous female. Greatly enlarged.

bodied, whitish-looking insect and may be discovered in infested fields by pulling up the unhealthy corn plant and closely examining the roots and surrounding soil. This kind of aphis depends entirely upon the services of a small brown ant, sometimes called the cornfield ant, in order to secure its food and the means of surviving the winter, and the presence of an unusual number of brown ants in cornfields may indicate an infestation of the corn root-aphis. The eggs of the insect are laid by a wingless female aphis (fig. 13) which develops only in the fall of the year. The ants carry the aphis eggs into their nests, caring for them all winter long, and in the spring when the eggs hatch the young aphids are carried out and placed in contact with the roots of certain wild plants such as smartweed. If corn is then planted in such infested places, the ants transfer the aphids to the roots of the corn plants, where they continue to live upon the sap, thereby robbing the corn of its nourishment and often causing a heavy loss to the crop.

FIG. 13.—The corn root-aphis: Egg-laying female.

### CULTURAL PRACTICES FOR THE CORN-ROOT APHIS.

Stir the soil thoroughly previous to planting. The object of this procedure is to disturb the ant colonies and scatter and kill the aphids so as to enable the plants to make a substantial growth before the ant

and aphid colonies can become reestablished, and also to prevent the growth of weeds upon which the aphids live, making it necessary for the ants to carry the surviving aphids to new fields. If infested fields are to be replanted to corn, plow them to a depth of 6½ or 7 inches in the spring after March 15. Follow this with three or four diskings to a depth of 4 or 5 inches with a 16 or 20 inch disk, the number of diskings and the intervals between them varying according to the length of the period between plowing and planting. When it is necessary to replant early injured corn, plow the field deeply and thoroughly and then give three or four deep diskings at intervals of two or three days. These practices necessarily involve additional labor, but they prevent root-aphis injury and also put the field in much better physical condition. Plowing in the fall before the ant colonies go below the plow line is sometimes as useful as spring plowing, but if warm weather follows, the ants may reconstruct their nests and reassemble the aphids so that replowing in spring will be necessary; but whether the field be plowed in the fall or the spring, the spring diskings are essential.

Early fall plowing, followed by frequent deep diskings in fields damaged by the root aphis that season, is a good practice from the standpoint of community control as well as for the personal benefit derived, because the plowing disturbs the ant colonies, kills many of the aphids, and destroys the weeds upon which they live, and disking prevents the recolonization of ants and prevents the growth of weeds, resulting in a significant reduction in the number of aphid eggs to carry the insect through the winter.

#### REPELLENTS FOR THE CORN-ROOT APHIS.

Where it is impossible to practice one of the foregoing measures, repellents may be used to advantage. The object is to repel the ants by the use of an odorous substance offensive to them, thus preventing them from colonizing the aphids on the corn roots or driving them from the treated field. These materials destroy neither the ants nor the aphids but tend to drive away the ants, the presence of which is essential to the life of the aphids. Oil of tansy, tincture of asafetida, oil of sassafras, anise oil, kerosene, and oil of lemon are useful for this purpose, one of these materials being mixed with a chemical fertilizer, such as bone meal, and applied by means of a planter equipped with a fertilizer attachment. They should not be applied directly to the seed, as such treatment may injure it, especially if the season be wet. One-fourth of a pound of oil of tansy should be diluted with 2 quarts of alcohol and 1 quart of water, 2 pints of asafetida should be diluted with 1½ gallons of water, and either repellent thus diluted should be added to 100 pounds of bone meal, this amount being sufficient for an acre.

## WIREWORMS.

Wireworms (see fig. 14) are especially destructive to seed corn in the ground and to the young corn and wheat plants. They work entirely underground and are among the most difficult to control of all the insect foes that afflict the farmer. Much may be done, however, to lessen their ravages by careful tillage, drainage, proper rotation of crops, etc., as will be explained.

Wireworms are the young of the common snapping beetles, or click beetles, and the worms are yellowish or brownish, highly polished and slippery to the touch. They move actively and disappear rapidly when brought to the surface by the plow or spade. The

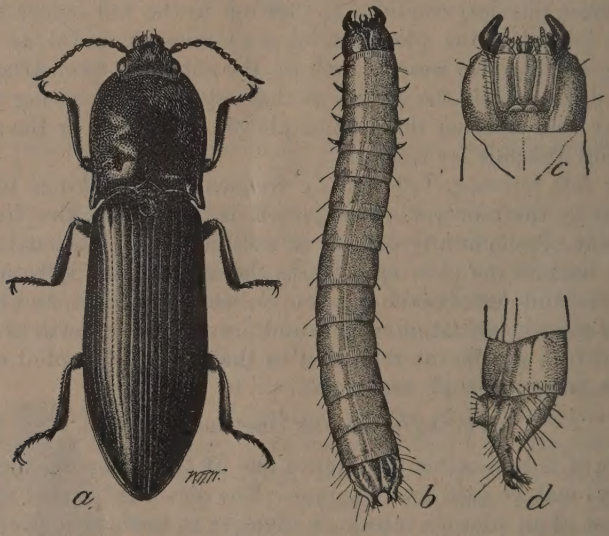


FIG. 14.—The dry-land wireworm (*Corymbites noxius*): *a*, Adult; *b*, larva; *c*, under surface of head of larva; *d*, side of last segment of larva. *a*, *b*, Enlarged; *c*, *d*, more enlarged.

eggs are laid in the ground, usually in sod lands, where the young worms are hatched. It takes three years for most kinds of wireworms to get their full growth and to become beetles.

### REMEDIES FOR WIREWORMS.

The most successful methods for the control of wireworms are cultural in nature, it having been found impossible, or at least impracticable, to poison them by any known means.

Where it is proposed to plant sod land to corn the following year, to prevent wireworm injury the land should be plowed immediately after the first hay cutting, usually early in July, and should be cultivated deeply during the remainder of the summer.

Land already in corn which is badly infested should be cultivated deeply, even at the risk of slightly root pruning the corn. This should be continued as long as the corn can be cultivated, and as soon as the crop is removed the field should be tilled thoroughly before it is sown to wheat.

In regions where wheat is seeded down for hay, any treatment of infested fields is precluded. Where the wheat is not followed by seeding to other crops, the fields should be plowed as soon as the wheat is harvested. This kills the worms by destroying their food supply and preventing them from preparing suitable sleeping quarters for the winter.

A thorough preparation of corn land and a liberal use of barnyard manure or other fertilizer is recommended, and a vigorous stand may be produced sometimes in spite of the wireworms by such treatment. Wherever practicable the interposing of crops not severely attacked by wireworms, such as field peas or buckwheat, between sod and corn tends materially to reduce the number of wireworms in the soil.

Some kinds of wireworms live only in badly drained land, and for this reason thorough tile draining of such fields is often very beneficial, especially where the general condition of the fields is improved by proper applications of lime and thorough cultivation.

In the Northwest and northern Middle West the dry-land wireworm (fig. 14) sometimes is very injurious. The following methods have been found to be valuable in the elimination of this pest: (1) Disk or drag harrow the summer fallow as early as possible in the spring in order to produce a dust mulch and thereby conserve the accumulated winter moisture; (2) continue the disking as often as is necessary in order to maintain the mulch and keep down the weeds; (3) plow the summer fallow in July or early in August and immediately drag; (4) plow the stubble as soon as the crop is removed.[1]

Do not plant grain, and especially corn, on freshly broken sod land if this can be avoided. To do so exposes it to almost certain injury by wireworms, cutworms, and white grubs. Plant such land first to soy beans, cowpeas, clover, alfalfa, or buckwheat, afterwards rotating to grain. The growing of any one kind of grain on the same land continuously is sure to result in damage from insect pests, and is bad agricultural practice. Adopt a good system of crop rotation suitable to your particular region. If you do not know the most approved system of rotation for your locality, ask your county agricultural agent or State experiment station for advice.

[1] Farmers' Bulletin 725 contains additional information on wireworms and will be mailed free of charge on application to the Secretary of Agriculture, Washington, D. C.

## POINTS TO REMEMBER.

(1) Watch the grain crops carefully for the earliest indications of insect outbreaks. Make a daily survey of the fields during the most active growing season, if possible.

(2) If an outbreak of any insect foe is discovered, apply promptly the remedies recommended in the foregoing pages.

(3) If in doubt as to the identity of the pest, promptly send a specimen, inclosed in a tight tin box, to your county agricultural agent, State experiment station, or nearest Federal entomological field station, accompanied by a request for information regarding it.

(4) Keep on hand at least a small supply of the standard insecticide preparations, such as Paris green, lime, and arsenate of lead. Very often the delay caused by the fact that these preparations are not immediately available is fatal to the crop attacked.

(5) Report serious outbreaks of insects to one of the authorities mentioned above. Federal entomological field stations charged with the investigation of cereal and forage insects are located at the following places:

*Arizona*—Tempe.
*California*—Martinez.
*Indiana*—West Lafayette.
*Iowa*—Sioux City.
*Kansas*—Wellington.
*Maryland*—Hagerstown.
*Missouri*—Charleston.
*Ohio*—Wakeman.
*Oregon*—Forest Grove.
*Pennsylvania*—Carlisle.
*South Carolina*—Columbia.
*Tennessee*—Knoxville.
*Texas*—San Antonio.
*Utah*—Salt Lake City.
*Virginia*—Charlottesville.

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